REPORT OF WATER QUALITY IN OTTY LAKE LANARK COUNTY

1974

Ministry of the Environment

Ontario

The Honourable George A. Kerr, Q.C., Minister

Everett Biggs, Deputy Minister

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IN

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LANARK COUNTY

1974

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and its surrounding environment to great stress. In some cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over-harvesting or by the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry.

1. Evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory.
2. Research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal.
3. Evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972 and 1973 in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

During the spring, summer and fall of 1971 under the guidelines of the Recreational Lakes Programme, the Ontario Water Resources Commission (now within the Ministry of the Environment) assessed the bacteriological, physical-chemical and biological aspects of Otty Lake water quality.[1] The lake water quality investigations showed that bacteriological quality was good at off-shore sampling locations. At that time, the lake also demonstrated a moderately low degree of enrichment based on measurements of water clarity, suspended algae (chlorophyll a) and nutrient concentrations. At the same time, the Ontario Dept. of Health examined 333 waste disposal systems on Otty Lake and found only 39% to be satisfactory. An abatement programme was begun in 1972 by the Private Waste and Water Management Branch of the Ministry of the Environment. The cottagers of Otty Lake are to be commended for their cooperation, for by 1974, approximately 75% of the waste disposal systems classed as "directly polluting" and as "public health nuisances" had been corrected. Additionally, the Otty Lake Cottagers Association initiated their own sampling programme in 1972 in cooperation with the Ontario Department of Health to define bacteriological quality in selected shoreline areas of the lake. The Association has also taken part in the Ministry's Secchi disc-chlorophyll "Self-Help Programme" which is designed to demonstrate the status of enrichment of the lake.[2]

This report on Otty Lake is one of a series dealing with water quality aspects of the recreational lakes studied in 1974. The data were collected for purposes of comparison with results from the earlier surveys in view of the extensive correction of faulty sewage disposal facilities which had occurred in the interim.

[1] Report on Water Quality in Otty Lake, 1971. Ontario Water Resources Commission, Recreational Lakes Programme. 31p.

[2] Robinson, G.W., 1973. Enrichment Status of Otty Lake, Lanark County. Water Resources Branch, Ministry of the Environment. 24p.

SUMMARY

In May and July of 1974, the bacteriological water quality of Otty Lake was very good and was well within the Ministry of the Environment Microbiological Criteria for Total Body Contact Recreational Use. No large bacterial inputs were detected in Otty Lake. The inlet from McClaren Lake had bacterial densities which were a little higher than Otty Lake but still much lower than the Recreational Criteria.

Otty Lake had been surveyed during 1971 before implementation of an abatement programme to correct faulty waste disposal systems. Despite the effect of rainfall on the 1974 survey following the abatement programme, the levels of fecal coliforms dropped slightly and may be attributed to the correction of faulty sewage disposal systems. The measureable effects of the abatement programme were not large but this is because the levels of fecal coliforms, prior to the programme (1971) were already very low.

A special neashore sampling programme confirmed that the regular Ministry of the Environment sampling points adequately monitored the bacteriological water quality of Otty Lake.

The lake chemistry results of 1974 differed only slightly from those of 1971. Dissolved oxygen was depleted in the bottom waters of the lake by late July and nutrient accumulation in the near bottom waters was extensive by the September survey. Good water clarity and moderately low concentrations of suspended chlorophyll _a_ (no change from 1971) characterized the mid-lake region of Otty Lake during 1974. Several "weedy" aquatic plant species were found in high density in shallow bays of the northern end of the lake.

PURPOSE OF THE SURVEY

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment: microbial contamination, and excessive growths of algae and aquatic plants. While the two problems can result from a common source of pollution, the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard when the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching a lake. If this is the only source of pollution, satisfactory water quality will then return since disease causing bacteria do not usually persist in lake water.

Problems due to nutrient enrichment may be long lasting even if further excess nutrients are prevented from entering the lake. Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and which are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, can support excessive growths of rooted aquatic plants and of microscopic free-floating plants called algae.

While aquatic weed beds provide shelter, and both algae and rooted plants provide food for many kinds of fish, excessive growths of either are undesirable since they can upset the oxygen balance in the lake, interfere with recreational uses, and greatly affect the lake's appearance. They do not, however, generally pose a health hazard.

In order to detect either of these conditions, the surveys were designed, and tests selected, to evaluate the current conditions of the lake with respect to:

- lakeshore development
- the distribution and abundance of bacteria
- changes in temperature, dissolved oxygen and water quality with depth
- plant nutrients and suspended algae
- densities and species of aquatic plants

DESIGN OF THE SURVEY

Sampling Locations and Frequency

A proper estimate of the bacterial population requires several measurements of bacterial densities over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which when taken at many lake stations, will give reliable bacteriological results.

Five day bacteriological, chemical and biological surveys were carried out from May 14 to May 26 and from July 21 to August 2. Also, inshore bacteriological sampling at 31 locations approximately 4m offshore (Figure 5) was carried out during the May and July surveys. Additional chemical and biological samples were collected over a three day period from September 24-26.

Samples for bacterial analysis were taken daily one meter below the surface at 22 stations established throughout the lake, as well as from one meter above the bottom at one mid-lake station (Figure 1).

Chemical samples were taken through the illuminated layer of surface water and from one meter above bottom at each mid-lake station, but at the inlet and outlet stations, were collected one meter below the surface. During the five day spring and summer surveys chemical samples were obtained on the first and fifth day. Through the three day fall survey they were collected each day. Separate samples for chlorophyll analysis were collected daily through the illuminated surface water at the mid-lake and inlet stations.

Aquatic plant samples were obtained from areas representative of sparse, medium and dense growth.

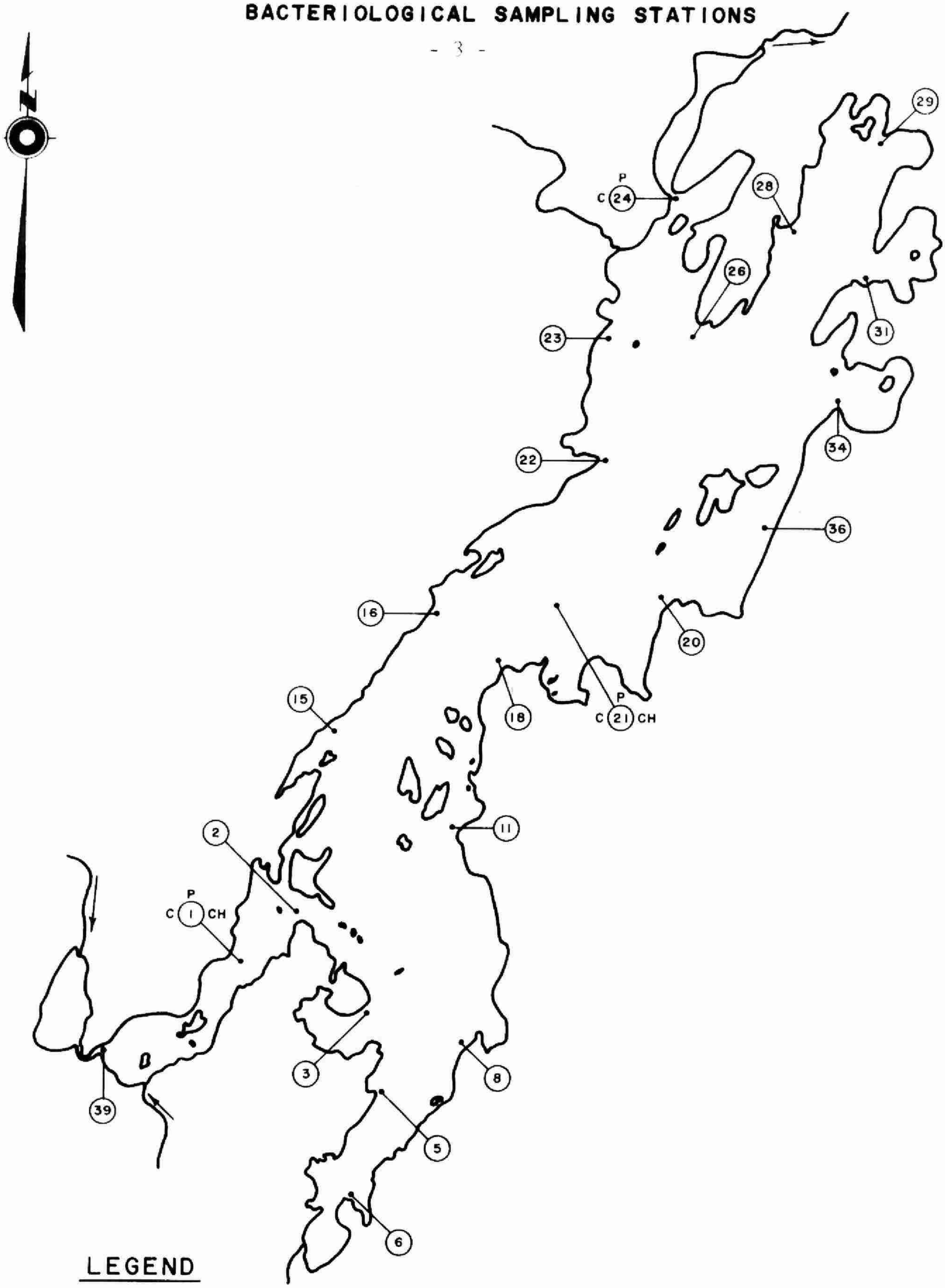
Field Tests

The variations in temperature and dissolved oxygen values with depth were measured at the one deep water station with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 2). The pH of the samples was also measured in the field.

Bacteriological Tests

The numbers of bacteria in each of three types of "indicator" organisms were determined on each sample. The three bacterial types, total coliform, fecal coliform and enterococcus (fecal streptococcus) bacteria are all indigenous to man and other warm blooded animals, and are found in the

FIGURE 1 - LOCATION OF CHEMICAL AND BACTERIOLOGICAL SAMPLING STATIONS



LEGEND

P
C (8) CH — SAMPLING STATION
D

C - CHEMICAL SAMPLE
P - PROFILE
CH - CHLOROPHYLL SAMPLE
D - DEPTH STATION
BACTERIOLOGICAL SAMPLES TAKEN AT ALL STATIONS
1971 NUMBERING SYSTEM USED

0 .5 1 KILOMETRES

0 1/4 1/2 MILES

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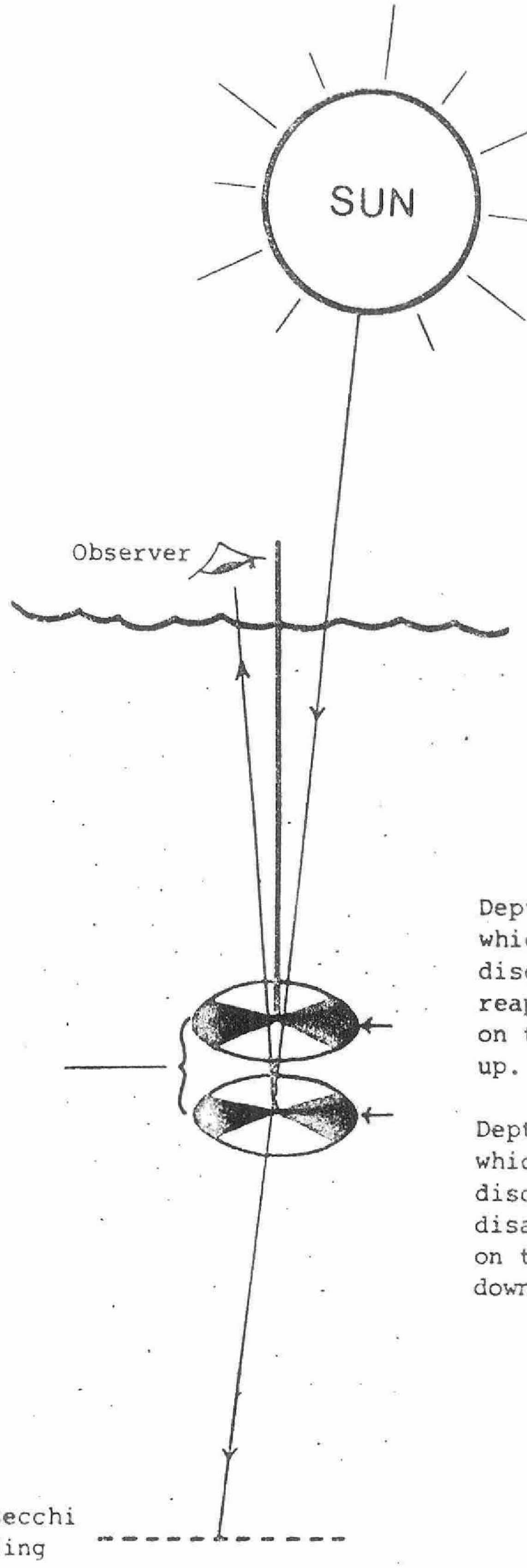
The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.



Clear, algae-free lake: Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake: Secchi disc readings tend to be less than 3m (9 feet).

FIGURE 2: USE OF SECCHI DISC TO DETERMINE WATER CLARITY

colon and feces in tremendous numbers. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. These indicator organisms in water connote the possible presence of disease causing organisms.

The density (numbers per 100 ml) of the indicator bacteria in water will vary considerably between pairs of samples taken at the same station, or at different stations on a lake, or if taken at different times, and so the assessment of water quality cannot be determined accurately from a single water sample.[1] Therefore, the bacteriological surveys require many samples to be taken at several lake stations over a period of time, and following this the large amount of data so obtained is reduced by calculation to meaningful and easily manipulated statistics.

> These data were then evaluated by statistical techniques in the following manner. The geometric mean, the most appropriate central value, and standard deviation were calculated for the values of each of the three bacterial types at every station, providing concise valid data. Statistically significant variations in the bacterial densities between stations, or groups of stations was determined by a One Way Analyses of Variance and Bartlett's Test of Homogeneity. By these means the data from each station were tested against that of every other station until all stations with similar geometric mean densities were separated into groups (Group A, B ---).

The group results, and those for individual stations, were then displayed on a map of the lake with each group identified by different stippling. Within each stippled area the group geometric mean applied for each type of bacteria, unless otherwise indicated by individual station values. The areas of better or worse bacterial quality were defined by the group geometric mean densities, and so any inputs of bacterial contamination, and the areas they affect, were readily identified.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques are affected by the mineral content.

[1]Guidelines and Criteria for Water Quality Management in Ontario - MOE, 1974.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is (apart from ammonia nitrogen) essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen (Ammonia, Nitrite and Nitrate) were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen may be regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of suspended algae in the water. The live algae are confined mainly to the illuminated surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by filling the sample bottle as it was lowered and raised from this depth, and were thus representative of the average algal density through this illuminated zone.

DESCRIPTION OF THE OTTY LAKE AREA

Lake and Soil Characteristics

Otty Lake is located in the Townships of North Burgess and North Elmsley in Lanark County. The Town of Perth, on Highway No.7, is located 5 kilometers (3 miles) northwest of the lake.

The entire body of Otty Lake lies in the Canadian Shield. Precambrian igenous and metamorphic rock form the bedrock along the north, west and south shores of the lake. The bedrock along the east shore is Precambrian limestone.

The majority of the land adjacent to the shores of Otty Lake consists mainly of a combination of soil-rock complexes. Exposed bedrock is predominant in the area although thin layers of organic materials up to 30 centimeters (12 inches) in depth occur in close association with the numerous rock outcrops. Small pockets of deep sandy loam up to a maximum of 1 meter (3 feet) are found in the irregular steep-sloping terrain. Most of the surrounding area is very stony. The land along the shoreline near Station 36 differs slightly from the land surrounding the rest of the lake. Here the terrain is gently sloping, moderately stony and has a thin layer of sandy loam till over the limestone bedrock.

Otty Lake has a water surface area of 650 hectares (1545 acres) and a shoreline length of 35 kilometers (22 miles). The mean depth of the lake is approximately 9 meters (30 feet) with a maximum depth of 27 meters (90 feet). Surrounding terrain is generally well-forested with birch, pine and some cedar.

There are four inlets to the lake, three of which have negligible flows. The creek that drains Thoms Mud Lake appears to be the only permanently flowing inflow. Jebbs Creek flows to the Tay River and is the only outlet. The private dam located on Jebbs Creek is responsible for the relatively low seasonal water level fluctuation of .5 meters (1.5 feet).

Lakeshore Development and Water Usage

The shoreline of Otty Lake is heavily developed with about 365 cottages and three resorts. The marjority of the cottage owners use the lake water as their source of domestic supply (see P.A-2). The lake supports recreational water sports such as fishing, boating, water skiing and swimming. According to information available from the Ministry of Natural Resources the most prevalent fish are northern pike, smallmouth and largemouth bass, yellow perch, rock bass pumpkinseed and other various forage species. Otty Lake has been stocked with smallmouth bass with some regularity since 1965.

RESULTS AND DISCUSSION

Bacteriology

In May and July of 1974, the bacteriological water quality of Otty Lake was very good and was well within the Ministry of the Environment Microbiological Criteria for Total Body Contact Recreational Use, which states:

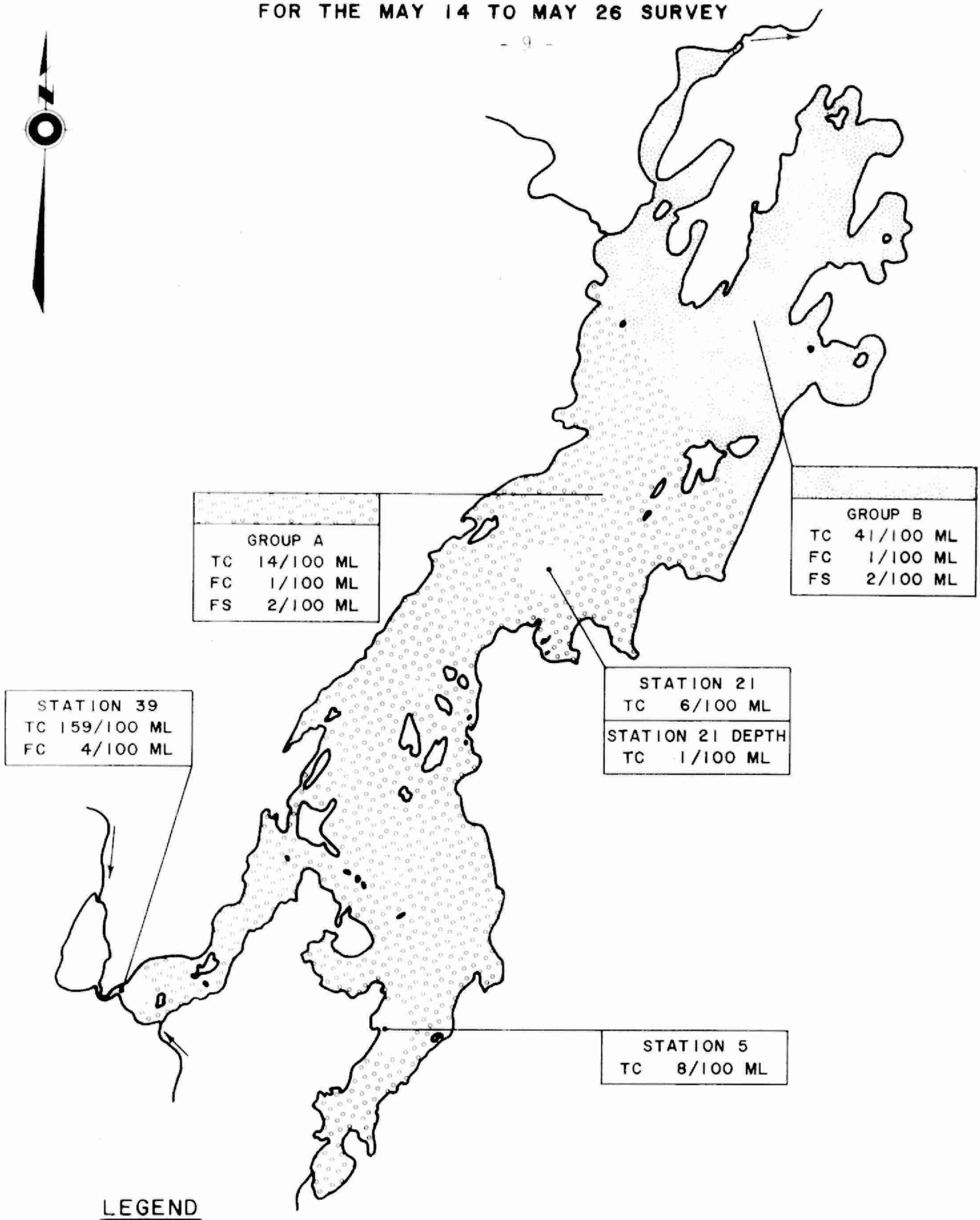
> "Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC) and/or enterococcus (fecal streptococcus, FS) geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively, in a series of at least ten samples per month....."[1]

In May, the major homogeneous section of Otty Lake had geometric mean densities of 14 TC, 1FC and 2 FS per 100 ml (Group A, Figure 3). A northern portion of the lake differed from the main body of water with a total coliform density of 41 per 100 ml (Group B, Figure 3). At the south-western inflow (Station 39), which drained McLaren Lake, higher bacterial densities of 159 TC and 4 FC per 100 ml were observed. In the south-eastern area, the western shoreline (Station 5) had a low total coliform geometric mean of 8 per 100 ml. The total coliform densities of the mid-lake surface and bottom waters (Stations 21 and 21D) were 6 TC and 1TC per 100 ml which were lower than the adjacent shoreline.

In July, the overall mean bacterial densities were 43 TC, 1FC and 3 FS per 100 ml (Group A, Figure 4). A northern shoreline area at the exit channel, (Station 24), displayed higher densities of fecal organisms with values of 15 FC and 20FS per 100 ml. Surveys on many Ontario lakes have shown that bacterial densities of inlet and outlet waters are frequently higher than the main portion of the lake. The relative levels of fecal coliforms and fecal streptococcus indicated that the fecal bacteria were probably of animal origin. Two northern shoreline locations (Stations 26 and 28) and the south-western inflow had fecal streptococcus densities of 10, 8, and 9 per 100 ml, respectively which were slightly higher than that of the main body of water. Total coliform increased in the mid-lake bottom waters (Station 21D) to 137 per 100 ml.

[1] *Guidelines and Criteria for Water Quality Management in Ontario - MOE 1974.*

FIGURE 3 - DISTRIBUTION OF FECAL BACTERIA FOR THE MAY 14 TO MAY 26 SURVEY



LEGEND

GROUP OR STATION	
TC	GM / 100 ML
FC	GM / 100 ML
FS	GM / 100 ML

GM - GEOMETRIC MEAN

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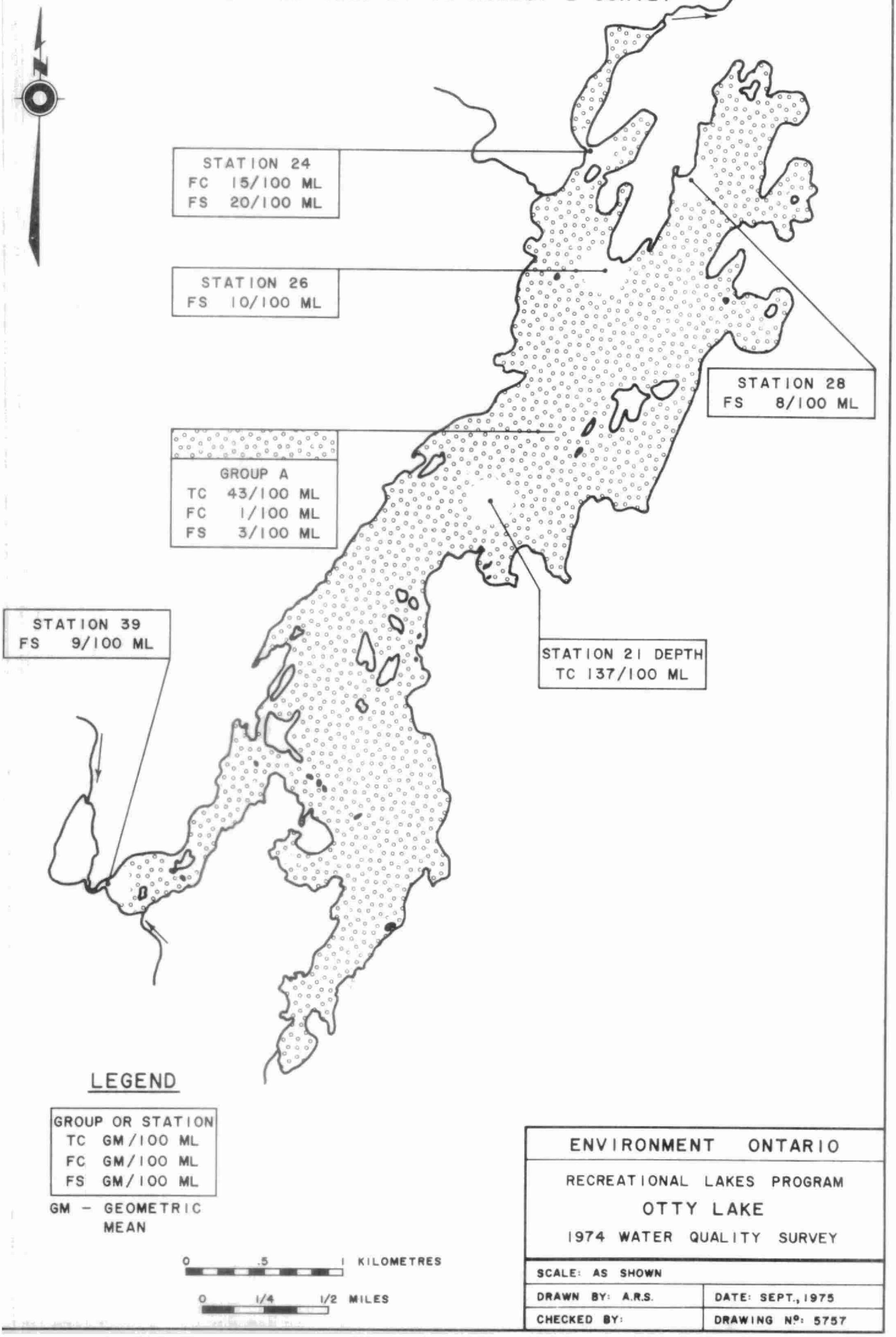
FIGURE 4 - DISTRIBUTION OF FECAL BACTERIA FOR THE JULY 21 TO AUGUST 2 SURVEY



Total coliform and fecal streptococcus densities were slightly higher in July (43 TC and 3 FS per 100 ml) than in May (14 TC and 2 FS per 100 ml). Higher summer densities are commonly observed in lakes and are probably due to an expected seasonal increase in temperature, wildlife, and recreational activities. Fecal coliforms were low throughout the lake except in the channel leading to the outfall, in the July survey.

The overall quality of the offshore waters of Otty Lake was previously assessed by the Ministry of the Environment in 1971, and at the same time the effectiveness of cottage waste disposal systems was determined (Cottage Pollution Control Programme, Interim Report 1971/72 MOE, Private Waste and Water Management Branch, August 1972). Many defective systems were corrected but an improvement in the bacteriological water quality was not obvious mainly because the bacterial densities were initially very low (Table 1). Fecal coliform with other bacterial densities are known to increase in lakes after rainfall.[2] The total coliform and fecal streptococcus densities in Otty Lake responded to the greater rainfall in 1974 (Table 1), but corresponding fecal coliform densities were slightly lower. This evidence suggests that the fewer fecal coliforms present in the environment in 1974 and may be attributed to the corrections resulting from the Cottage Pollution Control Programme.

The increase in total coliform density noted in 1974 is supported by statistical tests (Table 1), but is not of public health significance since natural yearly variations of similar magnitude, with high values accompanied by rainfall, were observed on an undeveloped lake.[3] Greater reductions in fecal coliforms were noted after a Cottage Pollution Control Programme was conducted on Cameron Lake, where higher initial levels of fecal coliforms were present.[4]

Nearshore Bacteriological Survey

To further characterize the inshore areas of Otty Lake many nearshore sampling points were established and sampled in May and July. The lake was divided laterally into three areas (A, B and C) (Figure 5), with about 30 sampling sites in each area. Nearshore samples were taken about 4m (12 feet) offshore, in contrast to regular samples taken 15-30m (50-100 feet) offshore.

[2] *Report on Water Quality in Harp Lake, District of Muskoka, 1973. Ontario Ministry of the Environment, Recreational Lakes Programme, 28p.*

[3] *Report of Water Quality in Jerry Lake, District of Muskoka, 1973. Ontario Ministry of the Environment.*

[4] *Report on Water Quality on Cameron Lake, 1973. Ontario Ministry of the Environment.*

TABLE I

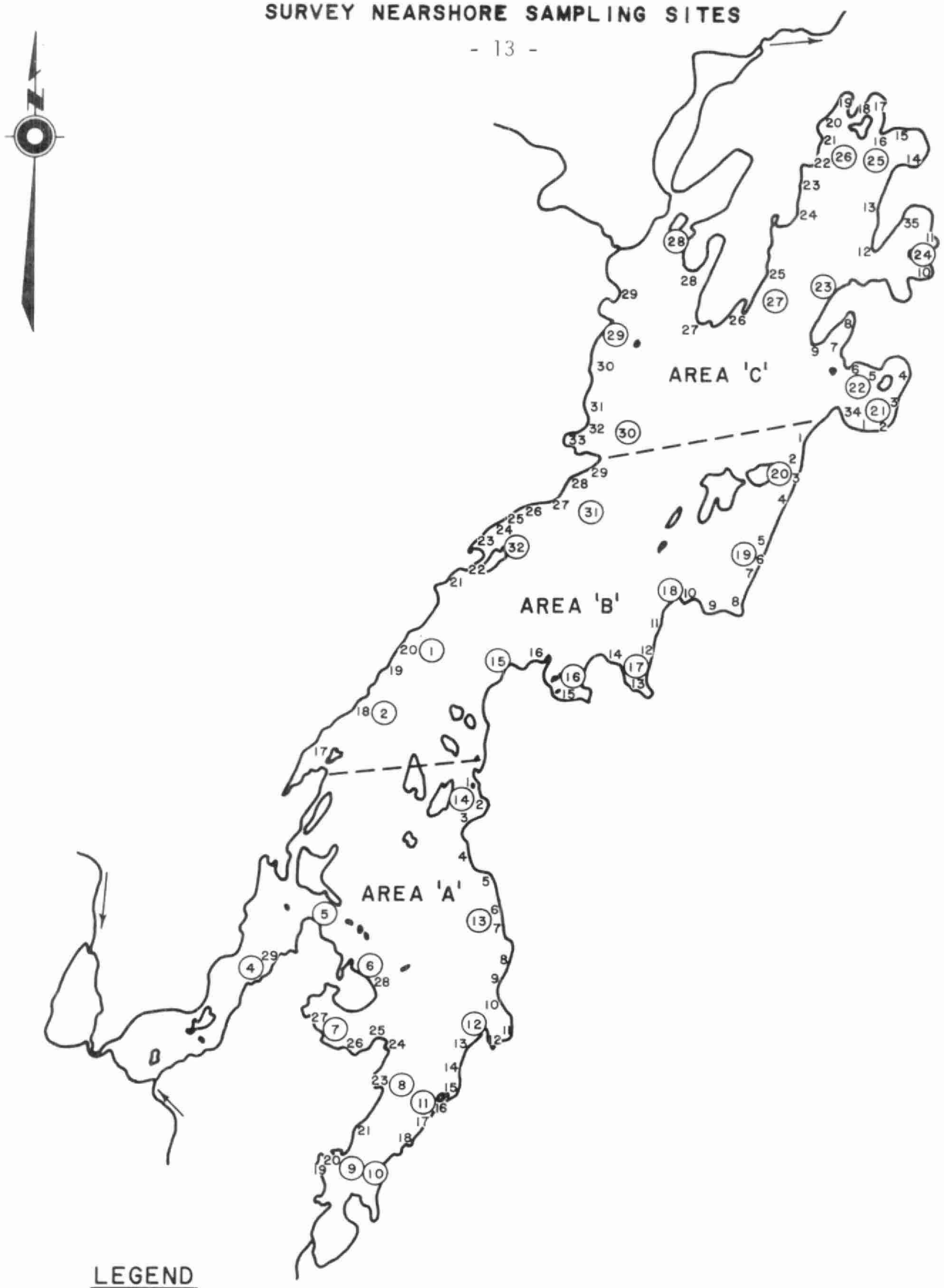
GROUP A BACTERIAL DENSITIES

PARAMETER	SPRING			SUMMER		
	June 1971 [1]	May 1974	t-test between '71 and '74 GMs [2]	August 1971 [1]	July 1974	t-test between '71 and '74 GMs [2]
TC/100 ml	10	14	SD*	3	43	SD*
FC/100 ml	2	1	SD	1	1	NSD
FS/100 ml	2	2	SD	2	3	SD*
Rainfall (in inches)	0.03	0.65		0.2	1.59	

1. 1971 Calculations based on the same sampling sites used in 1974.

2. Calculated at the 0.05 rejection level
*Calculated at the 0.01 rejection level

FIGURE 5 - LOCATION OF M.O.E., AND COTTAGERS SURVEY NEARSHORE SAMPLING SITES



LEGEND

(22) — COTTAGE SURVEY SAMPLING SITES

22 — M.O.E. NEARSHORE SAMPLING SITES

0 .5 1 KILOMETRES

0 1/4 1/2 MILES

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These new stations were intended to monitor only the developed shoreline. Each location was sampled for three days and analyzed for fecal coliform bacteria only.

Geometric mean densities were calculated for all stations for both surveys. In July the bacterial densities in descending order of magnitude were 3, 2, and 1 FC per 100 ml for areas C, B, and A. The July values tended to be higher than those of May.

The cottagers' pollution control committee, with the aid of the Ministry of Health Laboratories, surveyed the lake at nearshore locations in 1973. The field and laboratory methods differ from those of the Ministry of the Environment. A comparison was made between the July Ministry of the Environment nearshore data and the June, July and August results of the cottager's survey (Figure 5). The densities from both surveys are comparable but the 1974 data are generally a little lower (Table II).

A comparison was made between the fecal coliform mean densities of regular Ministry of the Environment and adjacent nearshore stations in July. Fecal coliform densities at the nearshore locations were usually slightly higher than the regular stations (Table III), and four of the differences were statistically significant. There were no large differences between regular and nearshore stations and so the regular Ministry of the Environment survey at sampling locations established in 1971 and used again during 1974, adequately determined the bacteriological water quality of the lake.

TABLE II

FECAL COLIFORM DENSITIES AT NEARSHORE LOCATIONS - 1973-1974

Cottagers Survey '73 June, July, August		Ministry of the Environment July '74	
Station	Geometric Mean FC per 100 ml	Station	Geometric Mean FC per 100 ml
Stations 21 - 28	5	Stations C 1-29 & 35	3
Stations 4, 6, 7, 11, 12, 13	2	Stations A 1 - 30	1
Stations 5, 8, 9, 10, 14	1		
Stations 1, 2, 29 - 32	3	Stations C 30 - 33 B 17 - 29	2
Stations 15 - 20	5	Stations B 1 - 16	2

TABLE III

July FC Values at Regular and Near Shore Locations

M.O.E.Near Shore Locations		M.O.E.Regular Stations		
Near Shore Stn. No.	GM. FC/100 ml	Corresponding Reg. Stn. No.	GM. FC/100 ml	T-test Reg. vs. Near Shore
29 A	1	1	1	NSD
21,23,24,A	1	5	1	NSD
11 - 15,30A	2	8	1	NSD
1 - 6 A	1	11	1	NSD
19 - 21 B	3	16	1	SD[x]
16 B	1	18	1	NSD
9 - 12 B	2	20	2	NSD
27 - 29 B	2	22	1	SD[x]
29 - 33 C	2	23	1	NSD
27 C	3	26	1	SD[x]
23,24 C	1	28	2	NSD
14 - 18 C	2	29	2	NSD
1C, 1B	5	34	1	SD[x]
3 - 6B	2	36	1	NSD

NSD not significant at the 0.05 rejection level

SD[x] significant at the 0.01 rejection level

Physical - Chemical Quality

Temperature and dissolved oxygen characteristics during 1974 were very similar to those observed during 1971. On May 14 of the spring survey, temperature and dissolved oxygen values varied little from surface to bottom. Temperatures ranged from 9.8°C (50°F) at 1.0 m to 7.5°C (46°F) at 25.0 m (one meter above bottom). By May 24, a thermocline (zone of rapid temperature decline) had formed between 5 and 7 meters and remained in this position throughout the balance of the survey. Dissolved oxygen exceeded 75% saturation from top to bottom throughout the May survey (Figure 6).

By July 27, the thermocline had shifted downward extending from 7 to 11 meters. Surface temperature had warmed to 21.8°C (71°F). Within the upper waters, dissolved oxygen remained near or above saturation but fell rapidly through the thermocline. No oxygen was present in the bottom waters at Station 21 (Figure 6).

The position of the thermocline on September 25 of the fall survey was between 11.0 and 13.0 meters. Upper waters (1.0 - 11.0 m) had cooled to a uniform 15.8°C (60°F) and dissolved oxygen was uniformly at 82% saturation from surface to 11 m. Dissolved oxygen dropped off dramatically through the thermocline and was essentially zero below 13 m (Figure 6).

Surface pH values at Station 21 tended to be about one unit higher than bottom values and varied little throughout each survey. Overall mean pH values were 8.1 and 7.2 units at 1.0 and 25.0 m respectively. Similar pH values were observed during 1971.

Total iron and chloride concentrations were low throughout the water column during each of the 1974 surveys. Total alkalinity and hardness indicate that moderately hard water conditions prevail in Otty Lake. Conductivity values correlated well with alkalinity and hardness values indicating no unusual mineral characteristics. The results of 1974 differed only slightly from those of the 1971 study (see table below; most values indicated are mean values at mid-lake sampling locations).

	Total Iron (mg Fe/l)	Conductivity (μmhos/cm)	Alkalinity (mg $CaCO_3$/l)	Hardness (mg $CaCO_3$/l)	Chloride (mg Cl/l)
1971	0.05	233	112	123	3.0
1974	0.05	235	103	119	2.5

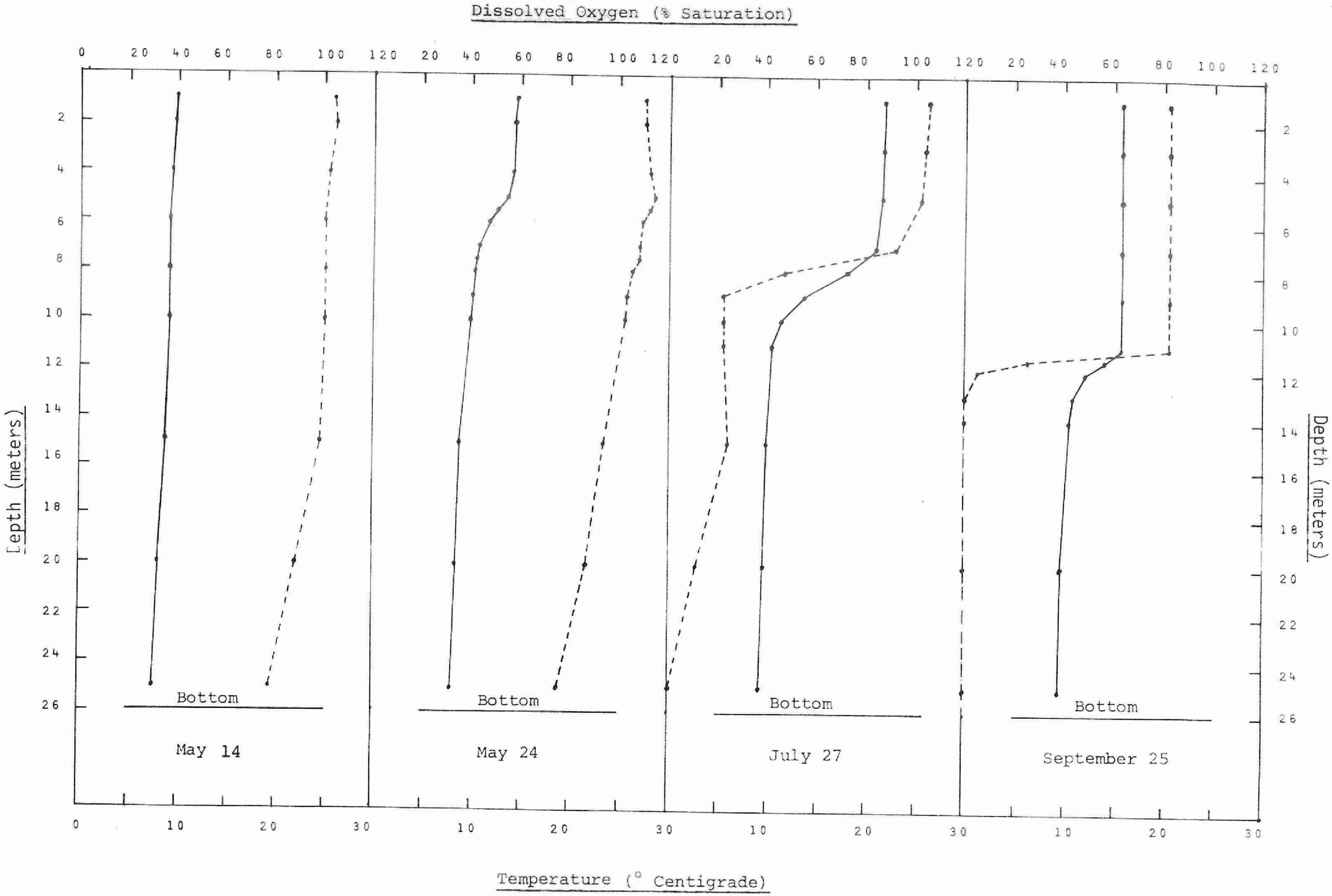


Figure 6: Temperature (—) and dissolved oxygen (---) profiles at Station 21 in Otty Lake, 1974.

Total phosphorus was found at moderate concentrations within the illuminated surface waters during the 1974 spring and summer surveys. Mean values were 0.019 mg P/l for each survey. Bottom water concentrations were much higher at 0.033 and 0.072 mg P/l during the spring and summer surveys, respectively. By the fall survey, average surface water concentrations of total phosphorus had increased to 0.026 mg P/l while bottom water values had reached 0.110 mg P/l.

Moderately high levels of Kjeldahl nitrogen were present in the illuminated surface waters of the lake. Individual values varied only slightly from the calculated 1974 mean concentration of 0.45 mg N/l. In the bottom waters, total Kjeldahl nitrogen concentrations were somewhat higher at 0.50, 0.53 and 0.71 mg N/l during the spring, summer and fall surveys, respectively.

High concentrations of total phosphorus and total Kjeldahl nitrogen were also found in the bottom waters of Otty Lake during the 1971 study (Table 4). Such high nutrient concentrations in the bottom waters coupled with severe depletions of dissolved oxygen, suggest that nitrogen and phosphorus were being released from the lake bottom sediments. A further indication of very poor bottom water quality was the obvious presence ("rotten egg" odour) of hydrogen sulphide in water samples drawn from near bottom during the fall survey.

Table 4. Concentrations of total phosphorus and total Kjeldahl nitrogen in both the bottom waters and in composite samples collected through the illuminated surface waters of Otty Lake during 1971 and 1974. Values given for 1974 have been averaged over the survey period.

		Total Phosphorus (mg/l)	Total Kjeldahl Nitrogen (mg/l)
June 13, 1971	composite	0.018	0.50
May, 1974	composite	0.019	0.44
	bottom	0.033	0.50
August 15, 1971	composite	0.016	0.49
	bottom	0.020	0.48
July, 1974	composite	0.019	0.47
	bottom	0.072	0.53
October 26, 1971	composite	0.012	0.46
	bottom	0.070	0.85
September, 1974	composite	0.026	0.43
	bottom	0.110	0.81

Although it appears that nutrient accumulation in the bottom waters during 1974 was greater than in 1971, the difference may relate to the sampling depth; mid-lake Station 37 of the 1971 survey was 20.0 meters deep while the repositioned Station 21 of the 1974 survey was 26.0 meters deep. Consequently it may be reasoned that water at the greater depth had been lacking in dissolved oxygen for a greater length of time and the nutrient accumulation could therefore be expected to be greater.

Chlorophyll a and Water Clarity

Good water clarity and moderately low concentrations of suspended chlorophyll a characterized the mid-lake region of Otty Lake during 1974 and little change has occurred in chlorophyll a concentrations since 1971 (see table below); 1974 data include results from both the "Self-Help Programme" and the Recreational Lakes Programme, while 1973 and 1971 results are from the Self-Help and Recreational Lakes Programmes, respectively).

	1971	1973	1974
Secchi disc (m)	3.2	4.1	4.1
Chlorophyll a (μg/l)	2.2	1.9	2.4

Although colour data are not available, the improved water clarity of 1973 and 1974 over that of 1971 may be related to a decrease in water colour in recent years.

Lakes exhibit their symptoms of enrichment in several ways (see p. A-6 for an explanation of the relationships among nutrient enrichment, water clarity and abundance of suspended algae). A curve relating chlorophyll a and Secchi disc values for a large number of Ontario lakes was derived by Ministry staff, and illustrates the moderately low enrichment status of Otty Lake relative to other well-known Ontario Lakes (Figure 7). Cottagers can help to maintain satisfactory quality (clear water and low algal density) of Otty Lake by ensuring that seepage of nutrients to the lake from waste treatment and disposal facilities does not occur.

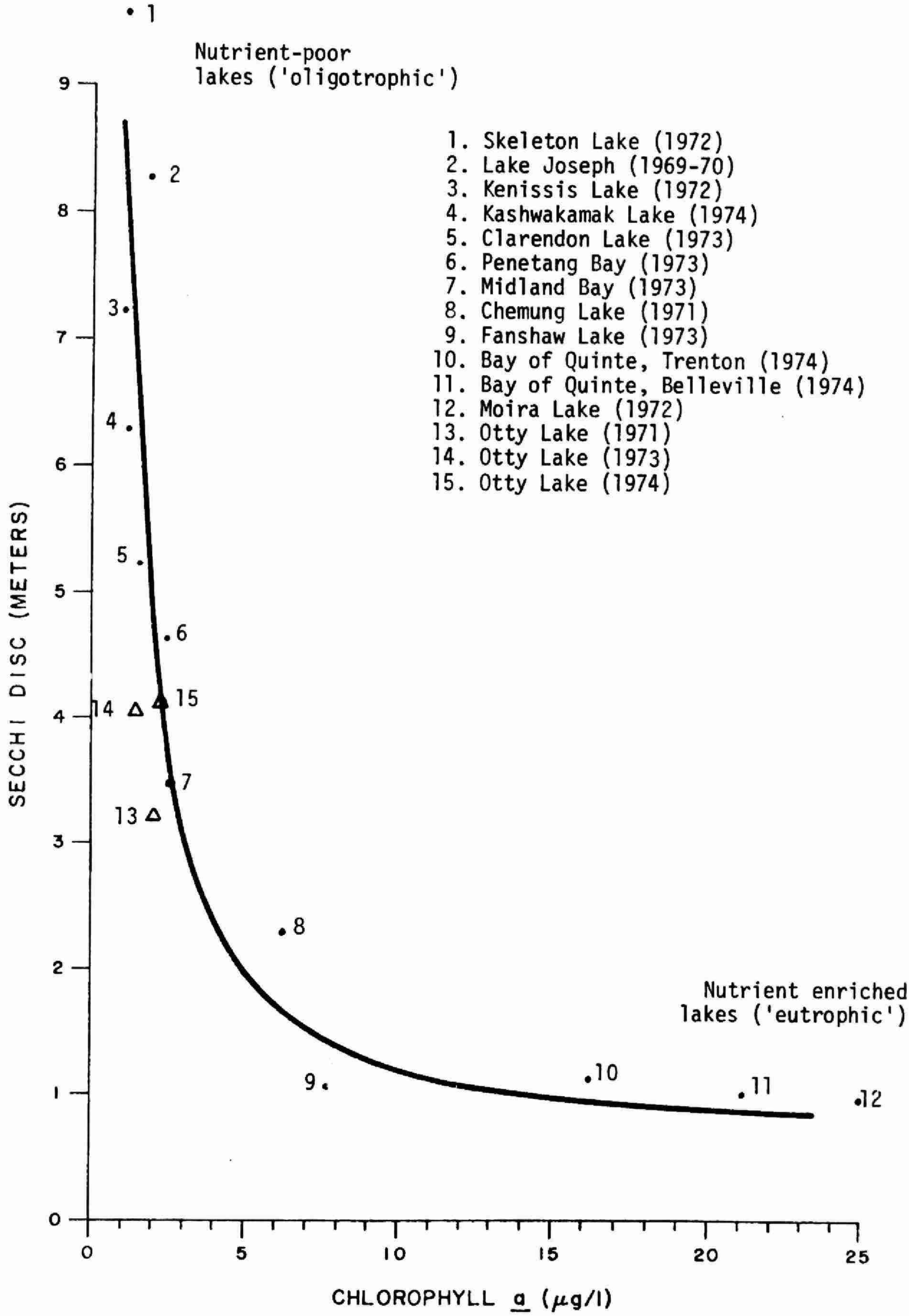


Figure 7: Relationship between chlorophyll a and Secchi disc developed from data on over 100 Ontario lakes and showing the status of enrichment of Otty Lake relative to several other lakes in the province.

Aquatic Plants

A large number (24 different species) of aquatic plants were identified from collections made in 1974 in Otty Lake (Table V). Those found to be most widely distributed and in greatest density (water milfoil, Canada waterweed, tape grass and several pondweeds) are commonly known as "weedy" types and are abundant in shallow, fertile lakes and ponds of northeastern North America. Most of the aquatic plant growth was found in shallow bays in the northern end of Otty Lake (Figure 8). There were extensive areas of shallow depth (affording suitable light penetration) in the central and southern parts of the lake which have escaped invasion by aquatic plants, possibly owing to the absence of bottom materials of suitable texture and fertility. Cottagers wishing to control aquatic plant growth in localized areas adjacent to swimming areas and docks should refer to p. A-10.

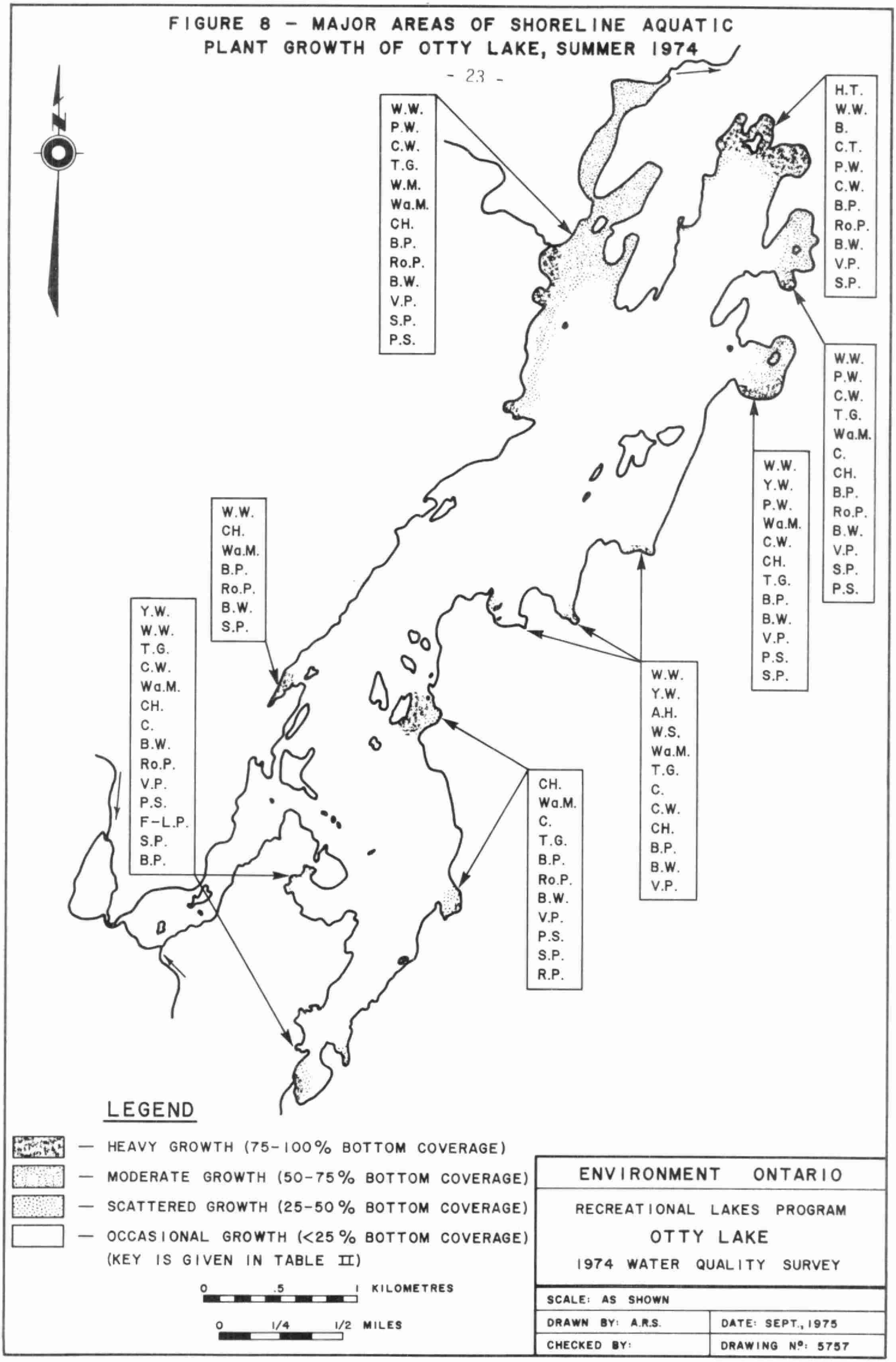


FIGURE 8 - MAJOR AREAS OF SHORELINE AQUATIC PLANT GROWTH OF OTTY LAKE, SUMMER 1974
W.W. P.W. C.W. T.G. W.M. Wa.M. CH. B.P. Ro.P. B.W. V.P. S.P. P.S.
H.T. W.W. B. C.T. P.W. C.W. B.P. Ro.P. B.W. V.P. S.P.
W.W. P.W. C.W. T.G. Wa.M. C. CH. B.P. Ro.P. B.W. V.P. S.P. P.S.
W.W. Y.W. P.W. Wa.M. C.W. CH. T.G. B.P. B.W. V.P. P.S. S.P.
W.W. CH. Wa.M. B.P. Ro.P. B.W. S.P.
Y.W. W.W. T.G. C.W. Wa.M. CH. C. B.W. Ro.P. V.P. P.S. F-L.P. S.P. B.P.
W.W. Y.W. A.H. W.S. Wa.M. T.G. C. C.W. CH. B.P. B.W. V.P.
CH. Wa.M. C. T.G. B.P. Ro.P. B.W. V.P. P.S. S.P. R.P.
LEGEND
— HEAVY GROWTH (75-100% BOTTOM COVERAGE)
— MODERATE GROWTH (50-75% BOTTOM COVERAGE)
— SCATTERED GROWTH (25-50% BOTTOM COVERAGE)
— OCCASIONAL GROWTH (<25% BOTTOM COVERAGE)
(KEY IS GIVEN IN TABLE II)
0 .5 1 KILOMETRES
0 1/4 1/2 MILES
ENVIRONMENT ONTARIO
RECREATIONAL LAKES PROGRAM
OTTY LAKE
1974 WATER QUALITY SURVEY
SCALE: AS SHOWN
DRAWN BY: A.R.S.
DATE: SEPT., 1975
CHECKED BY:
DRAWING Nº: 5757

Table V. Aquatic macrophytes found in Otty Lake during the summer of 1974. The plants are divided into two categories: (a) submergent - aquatic plants which live for the most part under water and (b) emergent - aquatic plants which produce floating or aerial leaves. An indication of the relative abundance of the plants and a key to the legend of Figure 9 is also given.

Scientific Name (Genus species)	Common Name(s)	Relative* Abundance	Key to legend of Figure 9
(a) SUBMERGENT			
Anacharis canadensis	Canada waterweed	ccc	C.W.
Ceratophyllum demersum	Coontail	cc	C.
**Chara	Stonewort	ccc	CH.
Fontinalis sp.	Water moss	c	W.M.
Myriophyllum sp.	Water milfoil	ccc	Wa.M.
Najas flexilis	Bushy pondweed	ccc	B.W.
Potomogeton amplifolius	Bassweed, large leaf pondweed	ccc	B.P.
P. gramineus	Variable pondweed	ccc	V.P.
P. natans	Floating-leaf pondweed	c	F-L.P.
P. pectinatus	Sago pondweed	c	S.P.
P. Richardsonii	Richardson's pondweed	c	R.P.
P. Robbinsii	Robbins' pondweed	cc	Ro.P.
P. strictifolius	Pondweed	cc	P.S.
Vallisneria americana	Tape grass, wild celery	ccc	T.G.
(b) EMERGENT			
Equisetum fluviatile	Horsetail	c	H.T.
Nuphar variegatum	Yellow waterlily	cc	Y.W.
Nymphaea odorata	White waterlily	ccc	W.W.
Pontederia cordata	Pickerelweed	cc	P.W.
Sagittaria latifolia	Arrowhead	cc	A.H.
Sagittaria sp.	Arrowhead	c	A.H.
Scirpus sp.	Cattail	c	C.T.
Typha latifolia	Bulrush	c	B.
Veronica catenata	Water speedwell	c	W.S.

*very abundant - ccc; common - cc; of rare occurrence - c.

**Chara is technically an alga, but because of its habit of growth, it is often given in lists of aquatic macrophytes.

INFORMATION OF GENERAL INTEREST TO COTTAGERS

MICROBIOLOGY OF WATER

For the sake of simplicity, the micro-organisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing micro-organisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less serious infections of gastro-enteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, sub-clinical infections usually associated with several waterborn viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately one year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attacked by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep-water fish species.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomenon that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in

fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination using a household bleach containing 4 to 5¼ percent available chlorine.

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometimes coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming strength at 5 percent available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
Per 10 ft. Depth of Water

Diameter of Well Casing in Inches	One to Ten Coliforms	More Than Ten Coliforms
4	0.5 oz.	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles, if water is periodically turbid, and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires under Part 7 of the Environment Protection Act that before you extend, alter, enlarge or establish any building where a sewage system will be used, a Certificate of Approval must be obtained from the Ministry of the Environment or its representatives. The local municipality or Health Unit may be delegated the authority to issue the Certificate of Approval. Any other pertinent information such as size, types and location of septic tanks and tile fields can also be obtained from the same authority.

(1) General Guidelines

A septic tank should not be closer than:

-50 feet to any well, lake, stream, pond, spring, river or reservoir

-5 feet to any building
-10 feet to any property boundary

The tile field should not be closer than:

-100 feet to the nearest dug well
-50 feet to a drilled well which has a casing to 25 feet below ground
-25 feet to a building with a basement that has a floor below the level of the tile in the tile bed
-10 feet to any other building
-10 feet to a property boundary
-50 feet to any lake, stream, pond, spring, river or reservoir

The ideal location for a tile field is in a well-drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the groundwater table or bedrock.

Recognizing that private sewage systems are relatively inefficient where shallow and inappropriate soil conditions are present (e.g. Precambrian areas) the Ministry of the Environment is conducting research into alternate methods of private sewage disposal in unsewered areas; into the improvement of existing equipment and methods of design and operation for these systems; and into the development of better surveillance methods such as by the use of chemical, biological and radioactive tracers to detect the movement of pollutants through the soil mantle.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems; however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING AND MARINA REGULATIONS

In order to help protect the lakes and rivers of Ontario from pollution, it is required by law that sewage (including garbage) from all pleasure craft, including houseboats, must be retained in suitable equipment. Equipment which is considered suitable by the Ministry of the Environment includes (1) retention devices with or without re-circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

Equipment for storage of toilet wastes shall:

1. be non-portable
2. be constructed of structurally sound material
3. have adequate capacity for expected use
4. be properly installed, and
5. be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1½-inch diameter National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. If the bilge is cleaned, the waste material must not be dumped into the water.
4. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
5. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
6. Empty oil cans must be deposited in a leak-proof receptable, and,
7. Slow down and save fuel.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

In recent years, cottagers have become aware of the problems associated with nutrient enrichment of recreational lakes and have learned to recognize many of the symptoms characterizing nutrient enriched (eutrophic) lakes. It is important to realize that small to moderate amounts of aquatic plants and algae are necessary to maintain a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool, which is essential to certain species of fish and also provides protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years during which extra nutrients are added to the lake and return to the natural state may also take a number of years after the nutrient inputs are stopped.

Changes in water quality with depth are a very important characteristic of the lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition in the bottom waters can aggravate the condition and in some cases result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of the lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result.

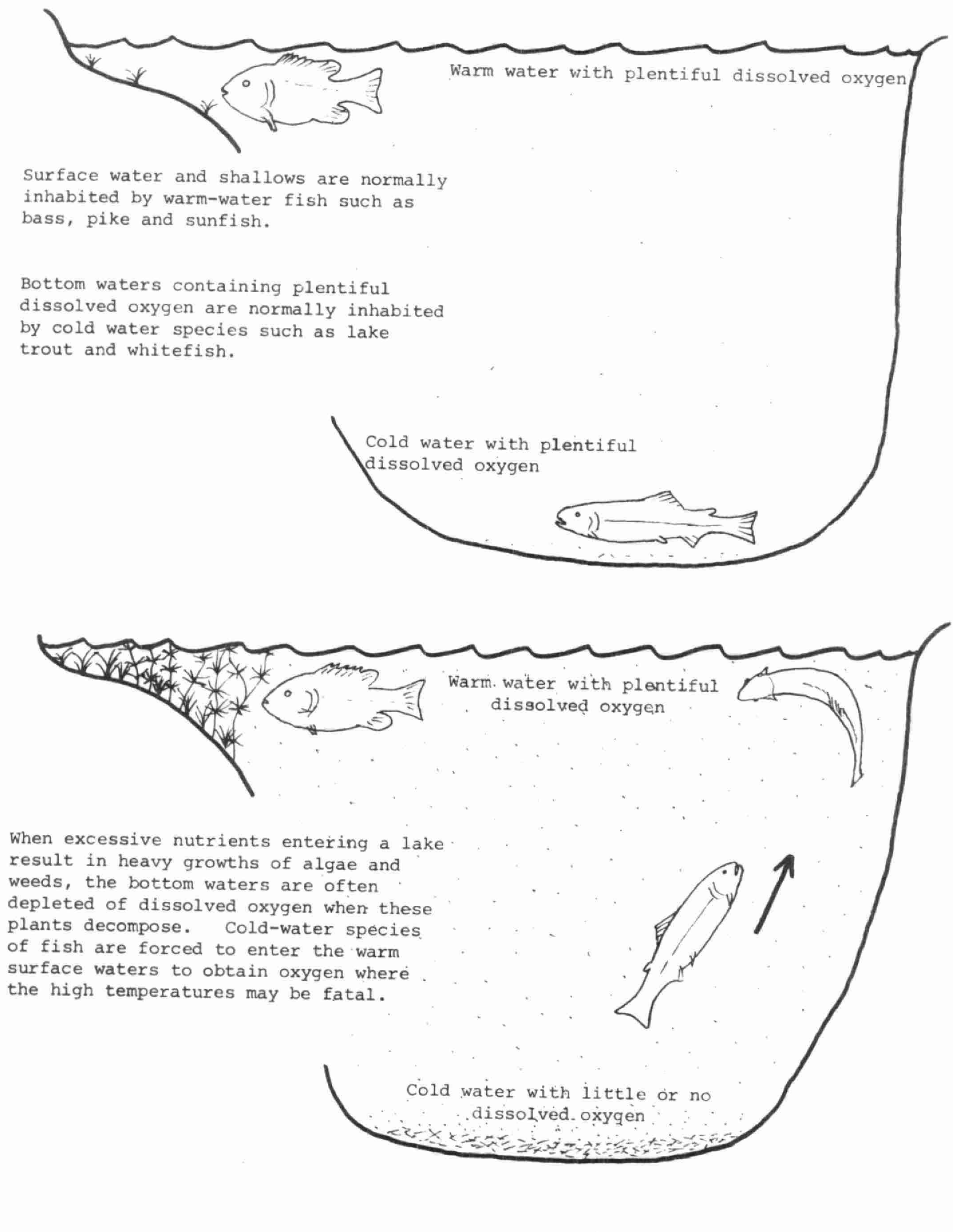


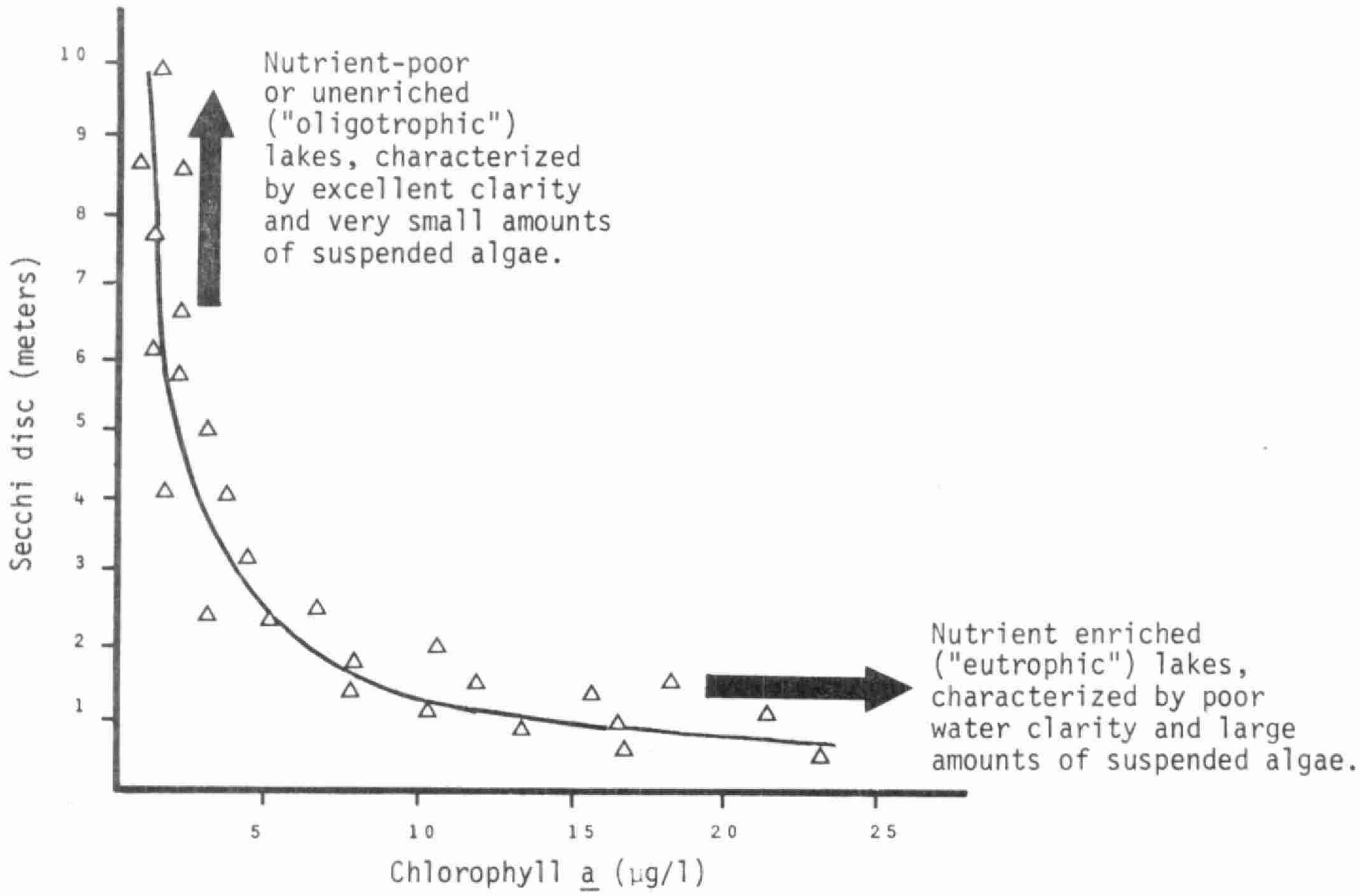
FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

Like humans, aquatic plants and algae require a balanced "diet" for growth. Other special requirements including those for light and temperature are specific for certain algae and plants. Chemical elements such as nitrogen, phosphorus, carbon, and several others are required and must be in forms which are available for uptake by plants and algae. Growth of algae can be limited by a scarcity of any single "critical" nutrient. Nitrogen and phosphorus are usually considered "critical" nutrients because they are most often in scarce supply in natural waters, particularly in lakes in the Precambrian area of the province. Phosphorus, especially is necessary for the processes of photosynthesis and cell division. Nitrogen and phosphorus are generally required in the nitrate-N (or ammonia-N) and phosphate forms and are present in natural land runoff and precipitation. Human and livestock wastes are a very significant source of these and other nutrients for lakes in urban and agricultural areas. It is extremely important that cottage waste disposal systems function so that seepage of nutrients to the lake does not occur since the changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

The large amounts of suspended algae which materialize from excessive inputs of nutrients, result in turbid water of poor clarity or transparency. On the other hand, lakes with only small, natural inputs of nutrients and correspondingly low nutrient concentrations (characteristically large and deep lakes) most often support very small amounts of suspended algae and consequently, are clear-water lakes. An indication of the degree of enrichment of lakes can therefore be gained by measuring the density of suspended algae (as indicated by the chlorophyll a concentration - the green pigment in most plants and algae) and water clarity (measured with a Secchi disc). In this regard, staff of the Ministry of the Environment have been collecting chlorophyll a and water clarity data from several lakes in Ontario and have developed a graphical relationship between these parameters which is being used by cottagers to further their understanding of the processes and consequences of nutrient enrichment of Precambrian lakes. The figure on the next page illustrates the above-mentioned relationship.

In the absence of excessive coloured matter (eg. drainage from marshlands), lakes which are very low in nutrients are generally characterized by small amounts of suspended algae (i.e. chlorophyll a) and are clear-water lakes with high Secchi disc values. Such lakes, with chlorophyll a and Secchi disc values lying in the upper left-hand area of the graph are unenriched or nutrient poor ("oligotrophic") in status and do not suffer from the problems associated with excessive inputs of nutrients. In contrast, lakes with high chlorophyll a concentrations and poor clarity are positioned in the lower right-hand area of the graph and are enriched ("eutrophic"). These lakes usually exhibit symptoms of excessive nutrient enrichment including water turbidity owing to large amounts of suspended algae which may float to the surface and accumulate in sheltered areas around docks and bays.



Measurements of suspended algal density (chlorophyll a) and water clarity are especially valuable if carried out over several years. Year to year positional changes on the graph can then be assessed to determine whether or not changes in lake water quality are materializing so that remedial measures can be implemented before conditions become critical.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Pesticides Control Section, Pollution Control Branch, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario M4V 1P5.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal growth in lakes and streams.

In past years, approximately 50 percent of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced the phosphate content (as P_2O_5) in laundry detergents from approximately 50 percent to 20 percent on August 1, 1970 and to 5 percent on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30 percent of the cottages in the Muskoka lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes because automatic dishwashing compounds are characteristically high in phosphorus. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes which are, in general, relatively low in phosphorus.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAMME

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90 percent of the population serviced by sewers. The programme is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. Specifically, the programme makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized, accelerated eutrophication.

Phosphorus removal facilities became operational at wastewater treatment plants on December 31, 1973, in the most critically affected areas of the province, including all the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition, which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the programme involved 113 plants, of which 48 are in prime recreational areas. An additional 53 new plants, each with phosphorus removal, are now under development, 23 of which are located in recreational areas. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons.

The 1975 phase will bring into operation another 54 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,00 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligram per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80 percent of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programs involving substantial funds and trained personnel. Limited use of approved larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Ministry of the Environment, Pesticides Control Service, 3rd Floor, 1 St. Clair Avenue West, Toronto, Ontario.